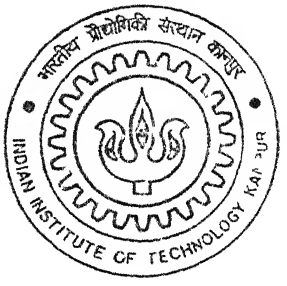
A Decision-Making Framework for IT Outsourcing using the Analytic Hierarchy Process

By

Vivek Pandey



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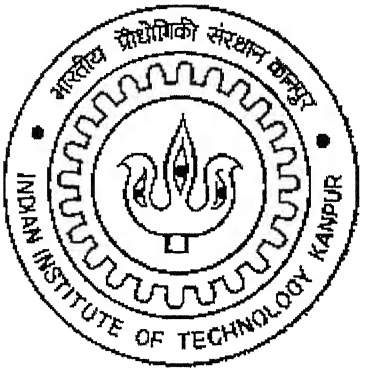

To
Department of Industrial and Management Engineering
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May 2003

CERTIFICATE

This is to certify that the work contained in the Thesis titled "A Decision Making Framework for IT Outsourcing using the Analytic Hierarchy Process" has been carried out by **Vivek Pandey** under my supervision and that his work has not been submitted elsewhere for a degree

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Abstract

Information Technology Outsourcing (ITO) has generated considerable research interest since the historic Eastman Kodak deals of 1989. Many companies at present are grappling with the ITO decision and issues related to it such as selecting outsourcable activities, choosing the right vendor and choosing the best outsourcing-methodology. Various decision-making models have been proposed in this area. In this thesis, a model has been developed for making part of the ITO decision based on the Analytic Hierarchy Process (AHP). Two hierarchies have been developed – one for making a choice of activities to outsource and another to choose the appropriate outsourcing methodology. AHP is well suited for the ITO decision because a high amount of subjectivity is involved in it. The model has been verified by applying it to an outsourcing decision made at a leading locomotives' company of India.

Acknowledgement

It would not have been possible to complete the present work had it not been for the invaluable guidance and support of my thesis supervisor Dr. Veena Bansal throughout the thesis work. I take this opportunity to thank her for her help and cooperation.

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Last but not the least; it gives me immense pleasure to thank all my colleagues and friends for making my stay at IIT Kanpur extremely productive, professionally as well as personally.

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ITO	Information Technology Outsourcing
BPO	Business Process Outsourcing
AHP	Analytic Hierarchy Process
BPR	Business Process Reengineering
J2EE	Java-2 Enterprise Edition
MRP	Materials Requirement Planning
ERP	Enterprise Resource Planning
SME	Small and Medium Enterprises
IS	Information Systems
MAUT	Multi-Attribute Utility Theory

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CHAPTER 1 Introduction

1. Problem Statement

Since the Eastman Kodak deals of 1989, Information Technology Outsourcing (ITO) has been at the center of attention. In the 1980s and early 1990s, it was the usual practice for companies, lacking in-house IT expertise and technology, to outsource their IT activities. However of late, this trend has changed and even companies as IBM, Microsoft and SUN, with strong IT capabilities, are outsourcing some of their IT functions. By doing this, they are able to focus on their core-competencies while the non-core activities are done by outside suppliers. Moreover, some companies are trying to align their IT strategy with their overall business strategy, and in some cases even vice-versa. By entering into strategic alliances and partnerships, businesses are trying to develop their internal capabilities and exploit the vast business opportunities offered by IT. ITO, in this context, serves to offer these companies a feasible transition period from IT-enabled to IT-centric business.

In outsourcing its IT functions, a company goes through the following five stages:

Stage 1. Assessment of the in-house IT capabilities

Stage 2. Deciding which activities to outsource

Stage 3. Finding suitable outsource partner(s)

Stage 4. Deciding the nature of the partnership(s) and details of the contract(s)

Stage 5. Managing the internal transitions, and relationship with the supplier(s), over the period of the contract

Each of these stages involves decisions to be made by managers. To the best of the author's knowledge, formal decision-making frameworks for ITO, which address these issues, are very few. These decisions are mostly made with the help of

consultancies, collecting market data, analyzing market trends, and doing case studies to identify similar situations and the methodology and outcomes thereof. The Analytic Hierarchy Process (AHP) enables the decision maker to express his qualitative judgments in a quantitative format. Thus, it transforms a subjective problem into a more objective one. Proposed in 1977 by Dr. T. L. Saaty, AHP has been widely employed in such diverse areas as resource planning for the government of Sudan and conflict resolution in Northern Ireland, to deciding the future of electric power utilities and corporate planning. However, extensive literature survey done by the author suggests that the applications of AHP to IT related areas, particularly ITO, have been rare. In the present work, AHP has been applied to the ITO decision problem.

2. Scope of present work

A model based on AHP has been developed for making the ITO decision. This model consists of two parts – one to decide the activities, which a company should outsource, and the other to decide the outsourcing methodology (vendors and contracts) to adopt. The model has subsequently been validated through its application to the outsourcing decision of a leading locomotives' company in India – Tata Engineering and Locomotives Company (TELCO), Lucknow. The data collected was analyzed using *Expert Choice*

3. Structure of the Thesis

Chapter 2 entitled "Literature Review" gives a brief sketch of the ITO problem and the various issues involved in ITO decision making. It briefly describes the present status of the problem.

Chapter 3 entitled "The Analytic Hierarchy Process" gives a description of AHP and issues involved in its implementation.

In Chapter 4 entitled "The decision-making model", the decision-making framework for ITO has been developed. This is done in two parts – one for the choice of

activities to outsource and another for the choice of the outsourcing methodology. AHP is used to develop both these parts of the model.

In Chapter 5 the survey methodology, results and analysis are presented.

Finally, in Chapter 6, some conclusions and scope for further research related to the issues dealt with in the present work are presented.

CHAPTER 2 **Literature Review**

1. ITO drivers

Earlier IT was perceived as serving two purposes – cost-reduction owing apparently to the "economies-of-scale" of the vendor and allowing the business to focus more on its "core-competencies" by offloading the non-core IT activities. Such a view that relates ITO only to "IS Improvement" has now been refuted. As suggested in [DiRomualdo et al, 1998], these tactical objectives are just one among the three kinds of strategic intents behind ITO. The other two are outsourcing for business impact and for commercial exploitation. The former focuses on improving ITs contribution to company performance within the existing lines of business while the latter focuses on leveraging technology-related assets – applications, operations, infrastructure, and expertise – in the marketplace through the development and marketing of new-technology based products and services.

IS improvement involves improving the IT processes of the company by increasing the productivity of resources and upgrading of technology and skills. The objectives here typically include cost reduction, service quality improvement, and acquisition of new technical skills and management competencies. The nature of the activity/activities being outsourced in this case determines the nature of the association with the supplier; if the risk perceived in the activities is high, there is a desire on the part of the customer to offload this risk to the supplier, as much as possible.

ITO can also be used to significantly improve critical aspects of business performance i.e. BPR, rather than just improving IT functionalities of the business. Rapidly emerging ITs are changing the way business is done. For example, while earlier MRP, Accounting, Finance etc. were IT-enabled separate processes, ERP integrated them and started replacing these "legacy" systems rapidly. However, even before ERP could reach saturation in business, the new model of web-services and ASPs, which is being aggressively pushed by IT giants such as Microsoft (.NET), Java (J2EE) etc., is emerging

rapidly [Hagel et al, 2001], [Lee et al, 2003], [Kirtland, 2003]. This, in essence, is a move from fragmented IT activities, to integration and then again fragmentation. Many companies, including those with strong IT capabilities, may find it hard to switch from their traditional business-processes to these new "paradigms". In such a scenario, ITO can free up financial resources and management attention, support the operation and maintenance of existing systems until they can be replaced, provide career paths for staff with "legacy" skills, and supply technical and business expertise to augment new initiatives.

ITO may also be done with the aim of commercial exploitation of IT. This involves improving material and human resources related to IT as assets to a point from where value can later be extracted from them. This value can be extracted by licensing systems and technologies developed initially for internal use, through selling IS-related products and services to other firms and by launching new IT-based businesses. This value can then be shared with the outsourcing partner thereby making the ITO strategy into one of value-added outsourcing [Lacity et al, 2001]. However, commercial exploitation of IT has been pursued less vigorously than the former two strategic intents [DiRomualdo et al, 1998].

Thus, it is seen that the goal of a company in ITO would be one among the above-mentioned three strategic intents viz. IS improvement, Business impact and Commercial Exploitation.

A different classification of ITO drivers has been proposed in [Goo et al, 2000]. According to the authors, the classification of [DiRomualdo et al, 1998] is very simplistic. They have developed a detailed taxonomy of ITO drivers using the more rigorous methodology of content analysis. Firstly, the contents of 49 major articles from leading publications have been carefully reviewed and as many as 243 ITO drivers suggested in them have been listed. Thereafter, using several theoretic foundations for categorization, these have been collapsed into a set of 14 major ITO drivers. These are listed in Table 1.

Table 1: A Preliminary Taxonomy of ITO drivers (adapted from [Goo et al, 2000])

Category	Definition	Grounded Theory	Various Expression of Objectives
1. Technical considerations	Intention of firm's procurement of lacked technical capabilities and skills through vendors rather than through building up internal technical capabilities and training internal staff	Resources and skills scarcity supported by theories of resource dependence and organizational learning	▪ access to advanced facilities ▪ access to cutting-edge technologies ▪ access to higher IT professionalism ▪ acquiring new IT related skills ▪ access to new ideas and technologies ▪ access to best technologies and talent, etc.
2. Risk management considerations	Purpose of risk management regarding internal IT investment in rapidly changing marketplace and technology	Uncertainty supported by TCE/IC	▪ transfer risks and problems to vendor ▪ avoid the risk of technical obsolescence ▪ eliminate an IT burden ▪ hedge/reduce risks of investing IT ▪ risk reduction in rapidly changing marketplace and technology, etc
3. Service quality considerations	Intention to increase the level of service through outside IT expertise that is already provided	Satisfaction supported by social exchange theory	▪ improve technology and technical service ▪ aggressive management of service and response time ▪ obtaining more integrated services ▪ better responsiveness to customer needs ▪ increasing IT service levels, etc.
4. Human resource considerations	Intention to be flexible to IS work arrangements and manage IS skills dynamically	Costs absorption mechanism supported by resource dependence theory	▪ downsizing ▪ adequate staffing for workload ▪ aggressive use of low-cost labor pool ▪ control seasonal workload ▪ eliminate inflexibility and fixed overhead, etc.
5. Costs control considerations	Company's intention to reduce IT costs by both eliminating waste wherever possible and managing cost structure through outside specialization and economies of scale	Efficiency of market transaction supported by TCE/IE and resource dependence theory	▪ facilitate core flexibility ▪ improve costs control ▪ IS cost reduction ▪ cost efficiency ▪ cost-effective bulk purchase and lease hardware and software, etc.
6. Financial and accounting considerations	Free up financial resources by liquefying IT assets and adjustment in accounting	Resource flows supported by resource dependence theory	▪ liquefy firm's intangible IT assets to provide seed money for the new IT ▪ infrastructure ▪ facilitate management of divestiture ▪ cash infusion ▪ free up financial resources
7. Shift (transform) IT roles and capabilities	Shifts the role of the IS function from acquiring and maintaining operations of computers to providing higher value work/capabilities	Importance of IT activities supported by resource dependence theory	▪ shifts the role of the IS function ▪ create a new IT capability ▪ an ability to refocus in-house staff on higher-value work ▪ align IT resources with business needs

8. Create IT based new lines of business	With the vendor's expertise of commercialization, leverage internal IT capabilities in the marketplace through IT-based products and services as a new revenue source	In-house cost efficiency supported by resource dependence theory	▪ commercial exploitation ▪ launching new IT-based businesses ▪ leverage current IT expertise in market ▪ new distribution channels for IT products and services ▪ create new electronic market process
9. Performance of existing overall business process	Improving IT's contribution to company performance with existing lines of business	Internal business process supported by resource dependence theory	▪ enhancing business performance ▪ improving IT's contribution to company performance ▪ improving productivity ▪ extend IT's contribution to critical business process ▪ technology-based BPR, etc.
10. Core competencies/differentiation considerations	As a way of competitive advantages and differentiations, accessing market efficiency for non-core activities	Competition supported by theories of firm strategy and organizational learning	▪ focus business on core competencies ▪ gain competitive advantage ▪ facilitate management focus ▪ competitive differentiation ▪ off-load responsibility for non-core, etc.
11. Creation/facilitation of alliance, M&A, venture	As a way of facilitating M&A and LBO and creating alliance, partnership, and venture	Efficiency of governance form supported by TCE/IC and agency theory	▪ strategic networks ▪ value-added partnerships ▪ creation of alliances ▪ creation of commercial ventures ▪ facilitate mergers and acquisitions, etc
12. Change management considerations	As a way of facilitating to pace with changing environment	Competitive isomorphic pressure supported by institutional theory and theories of organizational change	▪ jump on the bandwagon ▪ re-qualifying staff in leading-edge IT ▪ providing information to respond better to market changes ▪ tap rapid response to changing environment ▪ speed up the transition reliability and cost effectiveness, etc.
13. Time-to-market	As a way of speeding up the presence of market	First mover advantage by competition	▪ speed up new product introduction ▪ cut development time to new IT drive business ▪ decreases design-cycle time ▪ facilitating new product development ▪ rapidly developing new technologies, etc.
14. Enhancements and enrichment of information content using syndication	To create value-added information services by integrating/packaging contents of information goods created and distributed by syndicates from outside the organization	Leveraging abundance, not control over resource scarcity	▪ replace scarcity with abundance ▪ occupy the most valuable niches in syndication network ▪ value added by information manipulation ▪ assemble virtual corporation ▪ syndicated procurement in the Internet architecture, etc

This taxonomy is at a higher level of "granularity" as compared with the three strategic intents suggested in [DiRomualdo et al, 1998] but the latter form super-sets for the latter. It is easy to see that objectives 1 to 7 in Table 1 are towards IS improvement and 9 to 13 are for Business Impact. Element number 8 is for Commercial Exploitation of IT. However, element 14 cannot be readily fitted into the triangular schema of [DiRomualdo et al, 1998].

2. Deciding the activities to outsource

The first factor affecting the activity choice in ITO is the role played by the activity in the business process of the company. The strategic v/s commodity approach is the earliest and most elementary paradigm in this decision. In fact, there has been considerable debate on whether IT as a whole is a strategic asset or a utility for a company [Brynjolfsson, 1977 1996], [Clemons, 1991], [McFarlan et al, 1983], [Hamel et al, 1989], [Senn et al, 1999]. In the context of individual activities, if a particular IT activity is perceived as strategic to the business, it is kept in-house; if it is a commodity, it is outsourced to a supplier under the assumption that it would be able to provide the service at reduced cost due to the "economies of scale" it enjoys. However, this strategic v/s commodity (or core v/s non-core) debate has been rejected as being flawed and too simplistic [Lacity et al, 1995 and 2001]. Lacity et al (2001) propose a business factors matrix for deciding the activities to outsource. An activity is evaluated in terms of its contribution to business operations and business positioning. Based on this evaluation, the fate of the activity is decided as one among the four options of best source, outsource, insource and eliminate. This is illustrated through Figure 1

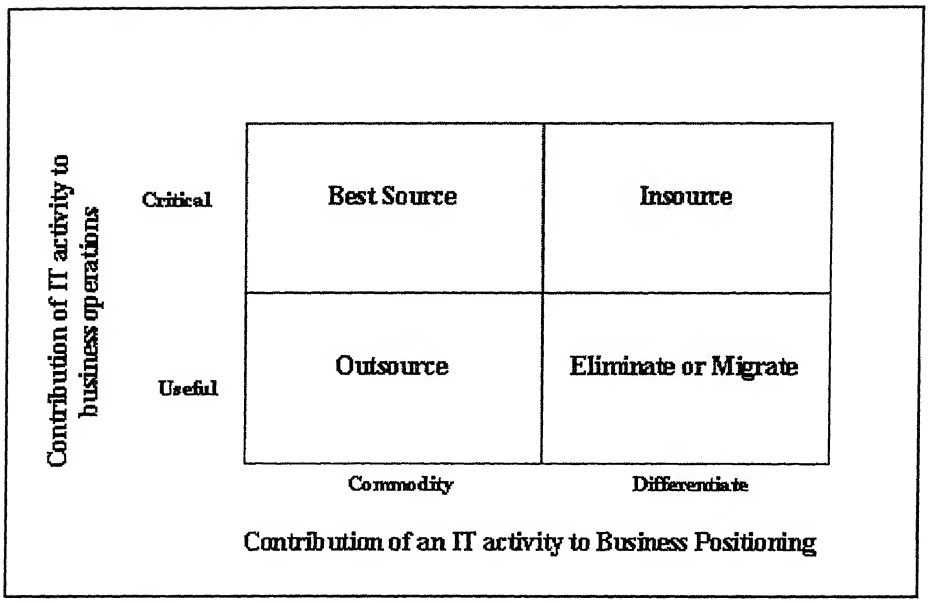

Figure 1: The business factors matrix (adapted from [Lacity et al, 2001])

Similarly, Aubert et al (2002) have proposed a resource-base framework for deciding which activities to outsource. Here the dimensions are strategic value and presence of strategic resources. Their contention is that the less the appropriate resources are present within the firm, the more the firm will seek to overcome this weakness by calling upon external suppliers; and the higher the strategic value of these resources the more the company is justified in preserving and exploiting them internally. This is illustrated through Figure 2. The strategic value is gauged along the vertical axis and the presence of strategic resources on the horizontal axis. The position of an activity on this matrix determines its fate. When an activity does not enjoy a strong strategic position, it is simply "outsourced". The considerations thereafter will be largely economic such as evaluation of vendors and contracts on more objective grounds. When the strategic value of an activity is high but the organization does not possess adequate resources for the same, it should enter into a collaborative partnership with the supplier. Through a survey of major companies in the US, Lacity et al (2001) have listed as many as eight common forms of such partnerships. When the strategic value is low but the organization has enough resources to carry it out, this matrix suggests that the activity should be recuperated. This will be through joint ventures with other companies or providing these resources to other customers. Finally, if the strategic importance of an activity is high and there is sufficient presence of resources to carry it out, it should be done in-house.

However, the authors use a more refined phrase – internal governance. That is, for strategic activities the company should fine-tune its IT governance structure.

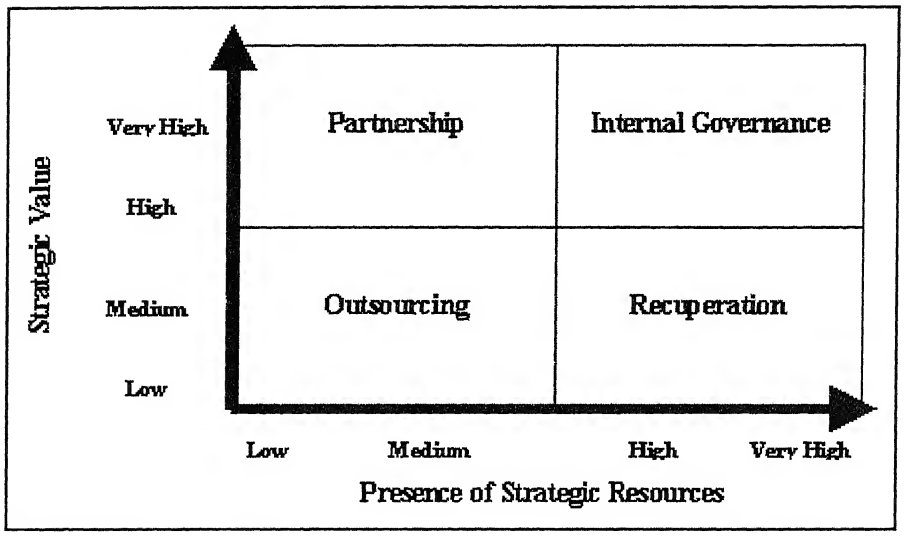

Figure 2: General framework for IT outsourcing (adapted from [Aubert et al, 2002])

The models of [Lacity et al, 2001] and [Aubert et al, 2002] are focused on the present business situation. On the other hand, Beath et al (1998) have suggested that the key to the outsourcing decision is having, first, a clear grasp of whether the prospective or future business processes will be unique or standard and, second, whether the existing or current business processes are unique or standard. While their unique/standard terminology is similar to the strategic/ commodity dichotomy, their emphasis on future prospects for an activity is noteworthy. For example, what is strategic today may become a commodity tomorrow.

While the role played by the activity in the business is an internal determinant, there are external determinants in the choice-of-activity as well. The second major factor influencing the choice of activities to be outsourced is obsolescence arising from the rapid changes in IT [Benamati et al, 1997 and 1998], [Boar 1994]. The rate of change in IT activities is estimated to be 20 to 30 percent per year [Allen et al, 1994] and is one of the highest among all business activities. Because of the lengthy duration of IT acquisition and implementation processes, many ITs become "old" even before actually contributing to their intended purpose. In such a scenario, companies are finding it

pragmatic to outsource IT activities, which they would otherwise have done in-house, to offload the risk of obsolescence to the supplier [Turner et al, 2002].

Another external factor in outsourcing decisions, which is probably more relevant for SMEs, is the complexity of IT activities. As noted above, IT is subject to rapid change. Such changes have generally introduced higher complexity into IT functions. For example, earlier the functions of Accounting, Finance, and MRP etc were separate applications within organizations. However, ERP systems have rapidly replaced these activities by integrating and bringing them together in a single environment. While development of these applications was simple, ERP requires considerably more technological skills and resources. Because of this, more and more companies are outsourcing ERP implementations rather than developing them in-house.

From the above, it follows that the major factors influencing the choice of activities to be outsourced can be classified as:

1. Strategic importance of the activity to the business, or its *criticality*
2. Prospects of future changes in the technology related to the activity i.e. its *stability*.
3. Skill and Resources required for carrying out the activity i.e. its *simplicity*.

3. Deciding the vendors and contracts

Once the choice of activities to be outsourced has been made, the next step is to select an appropriate methodology for outsourcing them. The issues involved in deciding the outsourcing strategy of a company are two-fold.

- Selecting the appropriate vendor
- Framing the appropriate contract

The issues of vendor selection and contract management are not new in management. Ian Macneil (1974) defines two extremes in contracting. "Contract transactions" are based on discrete exchanges – specific, clearly communicated, mutually beneficial, short duration exchanges. Market exchanges anchor the range at this extreme with short duration exchange relationships of standard commodities driven by considerations of price. At the other extreme of "Contract Relations", multiple exchanges occur over extended periods between a buyer and seller in which expectations of continuous future exchanges or the mutual dependence on an ongoing exchange relationship is the major mechanism that allows buyer and seller to exchange. Integration of buyer and seller into a single firm is the anchor at this extreme of exchange relationships. However, it would be difficult to force-fit ITO contracts into this schema. As Lacity et al (2001) point out; there are certain distinctive characteristics of IT that set it apart from most other business processes. Consequently, the issues of vendor selection and contract management also take on new dimensions in the context of IT. These distinctive characteristics of IT are

- heterogeneity of IT activities
- rapid changes in IT
- persistent difficulty in applying traditional economic concepts to IT
- limited validity of the "economies-of-scale" paradigm, and
- high switching costs

From a survey consisting of 271 interviews about 116 sourcing decisions made in 76 organizations, Lacity et al (2001) have listed eight different kinds of associations between the customer and the supplier in ITO. These are:

1. *Value-added Outsourcing*: In this, the supplier and the customer combine strengths to market IT products and services, or develop mutually beneficial internal business improvements. Value-added deals promise to overcome many of the limitations of

fixed-fee, exchange-based contracts, but the partners must truly add value by offering products and services demanded by customers in the market.

2. *Equity-holding Deals*: Some customers and suppliers have been signing equity-holding deals by taking ownership in each other's companies. This is done with the aim of increasing supplier's stakes and hence his involvement in the deal.

3. *Multi-sourcing*: With multi-sourcing, the risks of going with a single supplier are mitigated but replaced to a degree by additional time and resources required to manage suppliers. It differs from the general selective outsourcing strategy because here a conscious effort is made to put the suppliers in a competitive situation by Outsourcing related activities to different parties.

4. *Offshore Outsourcing*: IT functions are outsourced to different countries and continents. This enables companies to leverage low-cost and highly skilled workforce from other parts of the world, especially when these skills are in short supply or are very costly in the domestic market. In a global economy, the options available to companies for Outsourcing their activities are essentially unlimited. Offshore Outsourcing has allowed businesses to harness resources from across the globe depending on their requirements.

5. *Co-sourcing*: These are essentially performance-based contracts where payments to the supplier are tied to business performance of the customer.

6. *Business Process Outsourcing*: Various processes in a business may be fully, partially or not at all IT-oriented. For the partially IT-enabled processes, Outsourcing only the IT component in some cases, has been found to be cumbersome to manage. In these cases, businesses have outsourced the entire process such as Human Resource Management. This practice is now referred to as BPO.

7. *Spin-off*: Companies with strong IT capabilities, or those that went for insourcing or re-insourcing, have spun off their IT departments into separate companies.

8. *Creative contracting*: This category includes all other variants of the IT Outsourcing strategy such as starting with smaller deals deliberately before plunging into long-term contracts etc.

4. Decision-making models in ITO

While literature is replete with applications of various decision-making models and approaches to IS decisions, there are relatively few contributions in the field of ITO. Research in the field of ITO decision-making can broadly be classified into three categories: the ones with an economic view, the ones with a social view, and finally the ones with a strategic management orientation [Lee et al, 2000]. Work in the first category is mostly based on the tools of Organizational Economics such as Transaction Cost approach (for example [Aubert et al, 1996], [Nam et al, 1996]), Technology Acceptance model [Benamati et al, 2002] etc. These approaches suggest that firms are more likely to outsource routine activities i.e. those activities that are predictable and easy to measure. They also indicate that activities that require the use of specific resources should be managed in-house, in order to avoid the risk of lock-in with the supplier. Here, the "core-competency" and "strategic v/s commodity" approaches are taken ([Gordon, 1996], [Lacity et al, 1995] etc.). The second category concentrates on issues of relationships among the various stakeholders in the ITO decision environment. These would include people at various decision-making levels within the customer and supplier organizations, as well as sub-contractors [Lacity et al, 2001], [Lacity, 2002]. Contract management, Vendor Relationship management and management of IT Human Resources, as they integrate with the new business scenario post-outsourcing, are the three major areas of research in this category [Klepper, 1993], [Beulen, 2002], [Kern, 1997], [Gurbaxani, 1996], [Koh et al, 1995]. The third category focuses on the issue of integrating ITO with the overall business strategy instead of obsessing with the core-competency model and short-term goals. While outsourcing certain IT activities may make sense with respect to the objectives of efficiency of business operations and increased focus, reckless decisions might cost dear to the company in terms of loss of potential opportunities in extracting strategic advantage from ITO. This could be in terms of spin-offs, development of core capabilities etc.

AHP (explained in detail in Chapter 1) has been applied to ITO by Udo (2000). A generic model based on AHP for making the ITO decision has been proposed. The model consists of three levels. The goal is to "Select an IT management technique". The criteria for achieving this goal are the strategic importance, the stakeholders' interest, vendors' issues, cost operations and the industry environment. The alternatives from among which the choice is to be made includes the outsourcer, IT department and the end user. Their model is presented in Figure 3.

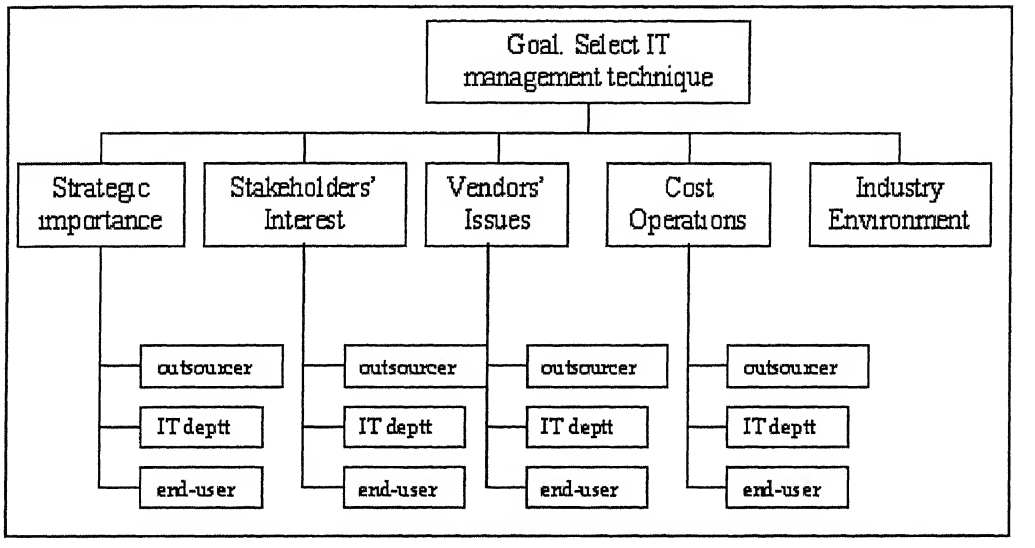

Figure 3: Hierarchy Model of Outsourcing Case (Adapted from [Udo 2000])

Later the author has presented a short numerical example to illustrate his model. Although the model appears highly generic, its utility lies in its value as a framework within which more elaborate and detailed models may be developed. In the present work, we try to make a more specific AHP-based model for decision-making in ITO. In the next chapter, the background and development of AHP as a decision making model have been presented, followed by a brief description of the method itself.

CHAPTER 3 **The Analytic Hierarchy Process**

1. The Science of Decision-making

Modern technology and psychology have attempted to tame the great decision-making dilemma of the 20th century. Application of the scientific method in the area of psychology has led to major revelations about how people make decisions, pointing out typical flaws in human interpretation of data that influences the choices and quantitative techniques for giving objective values to subjective "feelings". With the advent of computing power, along with the development of more sophisticated statistical analysis techniques, an opportunity arose to overcome the decision maker's prime obstacle viz. many disparate data to handle at one time. Approaches therefore began to focus on the process of data collection and analysis to support, and even to replace, human decision-making.

Human beings are not perfectly rational. Henri Poincaré had stated in 1906 - "But of all these paths, which will lead us most promptly to the goal? Who will tell us which to choose? We need a faculty, which will help us perceive the goal from afar. This faculty is intuition... Logic and intuition both have a necessary part to play. Both are indispensable. Logic alone can convey certainty: it is the instrument of proof. Intuition is the instrument of invention." This complex and significant role played by intuition in decision-making prompted various scholars from the social sciences, especially psychology, to delve deeper into the decision-making process. In 1944, John von Neumann and Oskar Morgenstern published a book on the Theory of Games and Economic Behavior [Neumann et al, 1944]. This book led to a flood of interesting applications in economics, statistics, psychology, and political science. Negotiation strategies, zero-sum games, the prisoner's dilemma, and so on are outcrops from their original ideas. It led in Utility theory to concepts of risk averse and risk seeking measures (a salaried worker is generally risk averse, while an entrepreneur is risk seeking for example). It also meant that utility had finally found a way of being measured, a reason for its abandonment at the end of the last century. Princeton University and the RAND Corporation took up the

banner from von Neumann's and Morgenstern's initiative, and pioneering work was done to develop methods that led to decision trees, game trees, and so forth. Game theory today is used for decision-making from developing war strategies to playing cards and chess.

Later in the 1950s, Herbert Simon set out to explore decision-making from a new perspective. His decision-making model remains a classic. He fragmented the decision-making process into three activities – the *intelligence* activity, the *design* activity and the *choice* activity [Simon, 1958]. The first step is to gather information, which is used in making the decision; the second step is to list *all* the alternatives available, their properties and potential outcomes; the last step is to choose the best among these many different alternatives and thus make the decision. However, since human beings are not completely rational in their decision-making but have a *bounded rationality.* Within this bounded rationality, the final decision is always *satisficing* and never *maximizing*. The knowledge available is limited, the ability to recognize all alternatives and predict their outcomes is limited and choosing the "best" alternative is again not possible due to "human" limitations.

In the 1960's and 70's Ralph Keeney, Howard Raiffa, and others began to pursue the idea that people express themselves through value systems - that is the real value of something is not only dependent on "the numbers" but also on what their real value is to a person. They called the value Subjective Equivalent Utility (SEU) or simply "utility". Gradually these efforts culminated in the emergence of a single theory called the Multiattribute Utility Theory (MAUT).

MAUT is a systematic method of identifying and analyzing multiple variables to provide a common basis for arriving at a decision. It has the ability to incorporate various, and possibly diverse viewpoints. Across its many variants, MAUT retains the following steps, in general.

1. Determine appropriate view point for the decision

2. Identify decision alternatives

3. Identify attributes for evaluation
4. Identify factors for evaluating the attributes
5. Establish a utility scale
6. Transform each factor value to its utility scale
7. Determine the relative weights for each attribute and factor
8. Calculate total utility for each of the decision alternatives
9. Determine which decision alternative has the greatest utility score
10. Perform sensitivity analysis

2. The Analytic Hierarchy Process

1.1. Background

In the 1970's, Thomas Saaty, originally a physicist, developed the Analytical Hierarchy Process (AHP) to measure the subjective "distance" between criteria. Saaty used a familiar tool of MAUT called pairwise comparison method in which each factor is compared against every other factor to establish ranked values (a tradeoff technique to prioritize criteria). While this approach had been tried before, Saaty felt the earlier mathematics seemed inappropriate and did not fit the problem. Further, there was no way of evaluating the subjective consistency with which these alternatives were being compared. As it happened, the consistency of judgments has emerged as one of the key issues for both decision researchers and decision makers alike. Saaty developed a mathematical approach using the techniques of matrix algebra, and in so doing provided a measure for consistency. Saaty's method initially impressed a wide range of decision makers, including the US State Department, which used it to test alternative foreign policy scenarios for real and potential events in world affairs.

1.2. Procedure

AHP essentially consists of two major elements – the decision hierarchy and the pairwise comparison scale. The decision hierarchy consists of the goal or the focus at the root and the means to achieve that goal at the leaves. Intermediate nodes consist of criteria on which the focus depends. This is shown in Figure 4.

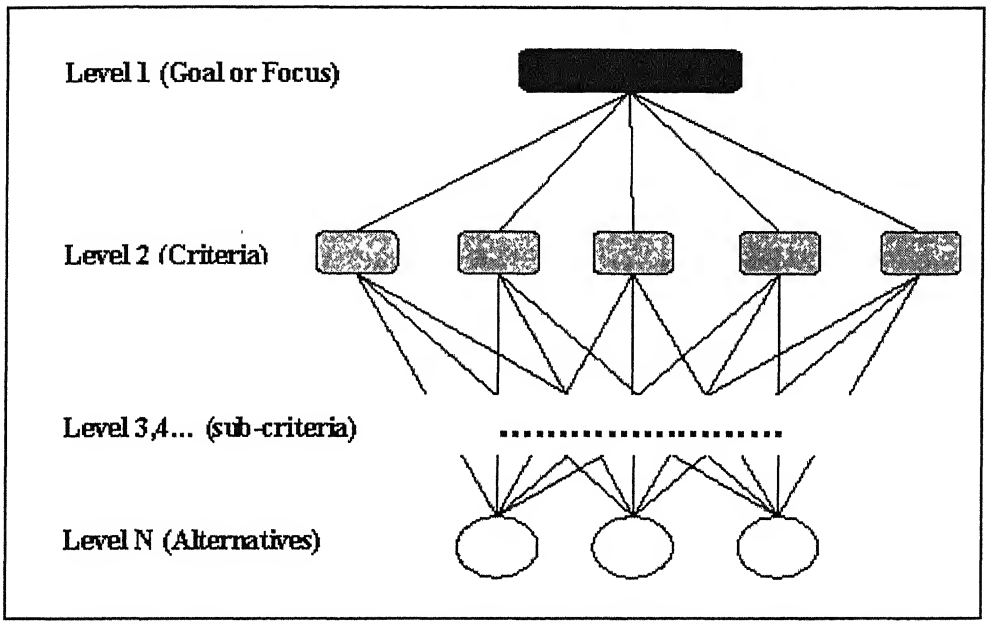

Figure 4: The decision-hierarchy in AHP

At the top level (Level 1) is the goal or focus, which is the main objective for which the decision is being made. As a simple example, feeling happy might be the goal or focus of an individual, cutting production costs might be the goal of an organization etc. At the second level are various criteria that play some part in the fulfillment of the goal. In the examples considered, increased salary and a big house could be the criteria towards the goal of happiness; downsizing and reengineering could be the criteria towards the goal of cost-reduction. Then there could be the intermediate criteria forming the intermediate levels. Increased salary could be achieved by either technical upgradation or doing away with work-related bad habits. Downsizing could involve either managerial staff reduction or technical staff reduction. In this way on or more intermediate levels may be formed. Finally at the lowest level lie all the alternatives that are being evaluated.

Given a set of criteria, how can it be decided which one is more important for the fulfillment of the goal (or a criterion at a higher level)? This question is answered by the second component of AHP viz. the pairwise comparison scale. The scale is used to rank a given set of determinants in order of their intensity of importance. It was developed by Saaty in his original work [Saaty, 1980]* and was based upon psychological premises. This scale is given in Table 2

Table 2: The Pairwise Comparison Scale [Saaty, 1982]

Intensity of Importance	Definition	Explanation
1	Equal importance of both elements	Two elements contribute equally to the property
3	Moderate importance of one element over another	Experience and judgment slightly favor one element over another
5	Strong importance of one element over another	Experience and judgment strongly favor one element over another
7	Very strong importance of one element over another	An element is strongly favored and its dominance is demonstrated in practice.
9	Extreme importance of one element over another	The evidence favoring one element over another is of the highest possible order of affirmation
2, 4, 6, 8	Intermediate values between two adjacent judgments	Compromise is needed between two judgments
Reciprocals	If activity *i* has one of the preceding numbers assigned to it when compared with activity *j*, then *j* has the reciprocal value when compared with *i*.	

The first step in making a decision using AHP is to make the decision-hierarchy as shown in Figure 4. Then the elements at each horizontal level are compared pairwise among themselves against a criterion in the next higher level. For this, questions are posed to a chosen set of respondents asking them to compare two nodes with respect to a common parent node in the hierarchy. Their responses are given a matrix representation as shown in Figure 5.

* [Saaty, 1980] pp 53-63

	C1	C2	C3	C4
C1	1	$X_{1,2}$	$X_{1,3}$	$X_{1,4}$
C2	$X_{2,1}$	1	$X_{2,3}$	$X_{2,4}$
C3	$X_{3,1}$	$X_{3,2}$	1	$X_{3,4}$
C4	$X_{4,1}$	$X_{4,2}$	$X_{4,3}$	1

Figure 5: The pairwise comparison matrix

In this figure, each of the items C1 to C4 is from a single horizontal level and is being pairwise compared to all the other elements from that level based on a particular criterion from the next higher level. Thus, if level x has K nodes and level $x+1$ has L nodes then to make pairwise comparisons for elements in level $x+1$, one will have to make use of K matrices (M_1 to M_K) of dimensions L X L. Each of the variables $X_{i,j}$ will take on values in the range $X_{i,j} \in (0,9)$. The diagonal elements will always be unity. A desirable property of this matrix, by virtue of the reciprocality in AHP's pairwise comparison methodology, is that

$$X_{i,j} = \frac{1}{X_{j,i}} \forall (i,j)$$

Next, for each matrix M_j the computation of the vector of priorities is done. One way of doing this is to compute the principal eigenvector of the matrix, i.e. the eigenvector with the maximum eigenvalue. When normalized, this becomes the vector of priorities. The eigenvalue corresponding to this eigenvector corresponds with the consistency (consistency is discussed later in this chapter). The required computations can easily be done using a simple computer program. As a result, K priority-vectors are obtained for level $x+1$, each vector having L elements. In case of level two, only one priority vector is obtained, as there is only one node – the root node – in the adjacent level. The ultimate objective is to obtain a *single* priority vector for each of the *leaf* nodes, i.e. nodes in the lowest level; this will denote the relative priorities of each alternative in terms of the goal or focus at the root node.

A formal algorithm for this is shown in Figure 6.

Step 1. $P\_VECTOR[1] = (1)$; $LEVEL = 2$; LOW = depth of hierarchy tree;

Step 2. For each node i in parent level $(LEVEL-1)$, form pairwise comparison matrices M_i for elements in current level $(LEVEL)$.

Step 3. Evaluate the eigenvectors with the largest eigenvalue* as $VECTOR\ [LEVEL]\ [i]$ for each M_i.

Step 4. Evaluate the priority vector as

$$P\_VECTOR[LEVEL] = \sum_i P\_VECTOR[LEVEL-1][i] * VECTOR[LEVEL][i]$$

Step 5 If $LEVEL$=LOW, STOP.

---

* To obtain the eigenvector of a matrix, the rigorous method is to successively form the products $M_i e, (M_i^2)\ e, (M_i^3)\ e, \ (M_i^k)\ e$ where e is an n^{th}-order column vector with all elements unity For sufficiently large values of k, the vector $(M_i^k)\ e$ will be a close approximation to the required eigenvector Computations are stopped when the differences of $(M_i^{k+1})\ e - (M_i^k)\ e$ are smaller than a threshold value say 0 0001 [37]

Note $VECTOR\ [LEVEL][i]$ denotes a vector while $P\_VECTOR[LEVEL][i]$ denotes one element from the vector $P\_VECTOR[LEVEL]$

Figure 6: The AHP in algorithmic format.

Thus, we end up with a priority vector associating each alternative course (lowest level nodes) of the decision with a value between zero and one. The course with the highest value is selected.

1.3. Consistency

One of the major issues in AHP is consistency. When making pairwise comparisons, each comparison is made independent of the other. However, this assumption is untenable. For example, consider the example of the individual seeking happiness in life. When asked whether he considers a big house or a compatible life

partner as more important for happiness, he might respond with a big house. Between a compatible life partner and a high salary, he may choose a compatible life partner. Then between a high salary and a big house, he may choose a high salary. These responses are mutually inconsistent. This inconsistence arises due to the requirement of transitivity in relations. That is,

$$(a_i > a_j) \wedge (a_j > a_k) \Rightarrow (a_i > a_k)$$

This, as discussed in the example above, might not hold among the pairwise comparisons of AHP. More important than consistency is the notion of cardinal consistency where the intensity of the preferences transits through the sequence of objects in the comparison. For example,

$$(a_i = 4a_j) \wedge (a_j = 7a_k) \Rightarrow (a_i = 28a_k)$$

This consistency is a desirable, although not a sufficient criterion for capturing reality. AHP needs some measure of consistency in the analysis. One measure is the Consistency Ratio (C.R.). If the value of this index is less than a specific threshold, generally taken as 0.1, the observations are rejected as being inconsistent. The *C.R.* for a given matrix M is calculated as follows. First, we calculate a Consistency Index *C.I.* as $C.I. = (\lambda_{\max} - n)/(n-1)$. Here, $\lambda_{\max}$ denotes the principal eigenvalue and n is the number of activities (elements) in the matrix. $\lambda_{\max}$ can be obtained in many possible ways. The most accurate method is to obtain powers of the matrix M as $M^1, M^2, M^3 \ldots M^{k-1}, M^k$ until the difference between M^k and M^{k-1} falls below a threshold value. Then, $\lambda_{\max}$ is the normalized vector of row-sums of the resultant matrix. Then we obtain the *C.I.* for a randomly generated reciprocal matrix from the scale 1 to 9, with reciprocals forced. Random matrices represent a complete lack of consistency, and hence provide a kind of "baseline" by which one can compare a genuinely judged matrix. The average consistency index obtained by generating large numbers of random matrices is called the Random Index (*R.I.*). Using these two, the *C.R.* is calculated as $C.R. = C.I./R.I.$. This method was proposed by Saaty in the original book on AHP. The lesser the value of *C.R.*, the more consistent the matrix is.

3. Concluding remarks on AHP

AHP has been applied in various diverse fields ranging from the public sector resource allocation problem in Sudan, to small day-to-day decisions such as switching between jobs. In real life organizational problems, AHP is typically used in conjunction with a questionnaire. Respondents are carefully chosen from different sections of the organization and their responses are used to prepare the pairwise comparison matrices. A commercial software known as *Expert-Choice* (Forman, Saaty, Selly and Waldron, 1983) is also available for AHP.

Although AHP is a widely used decision making methodology, its validity and reliability has been questioned in many places. Some of the major contentious issues have been the ambiguity of its elicitation questions, the degree of reliability of the 1-9 scale and the choice of method to average out inconsistencies among varying responses. Another serious drawback of the AHP has been that of rank-reversals. It has been shown clearly that "the ranking of alternatives determined by the AHP may be altered by the addition of another alternative for consideration". Examples of this anomaly have been reported in various places [Dyer, 1990]. AHP also makes a heavy demand on the respondent in terms of maintaining consistency because the number of comparisons to be made for even small real life problems is very large.

However, despite these shortcomings (which are continually debated upon), AHP is a widely used methodology for making decisions involving a high degree of subjectivity. The central task remains the formulation of hierarchy, which is what is done in the present work for the case of the ITO decision.

CHAPTER 4 The decision-making model

1. Deciding the activities to be outsourced

The nature of an IT-activity may be ascertained along the following dimensions:

- *Criticality:* Criticality of an activity depends upon its interdependence with other processes and its role in the strategic positioning of the business. In practical use, decision-makers would have to answer the question – "Is activity A more critical to our business that activity B?" Since competitiveness and positioning of the business are directly affected by the performance of its core or critical activities, higher the criticality of an activity lower is the support for outsourcing it.

- *Stability.* Stability of an activity depends on the prospects and market-scenario of the technology involved in it. If the technology related to the activity is rapidly changing, or is expected to behave in like manner in the future as well, then it is not a stable activity. Risk associated with an activity is a direct corollary of its stability – that is, its susceptibility to change, standardization etc. Since a business will try to minimize the risk, higher is the stability lower is the support for outsourcing.

- *Simplicity:* Simplicity of the activity is in terms of the technology and concepts involved in its implementation. A higher simplicity will increase the ease of insourcing it. Hence, in the case of ITO, higher the simplicity lower is the support for outsourcing. Simplicity becomes particularly important for companies with weak IT capabilities.

The goal, or focus, is to decide which activities to outsource. The alternatives are the activities themselves. The priority vector for all business activities can be generated using the pairwise comparison method where the above three factors play the role of the criteria. The decision-hierarchy for this decision is shown in Figure 7.

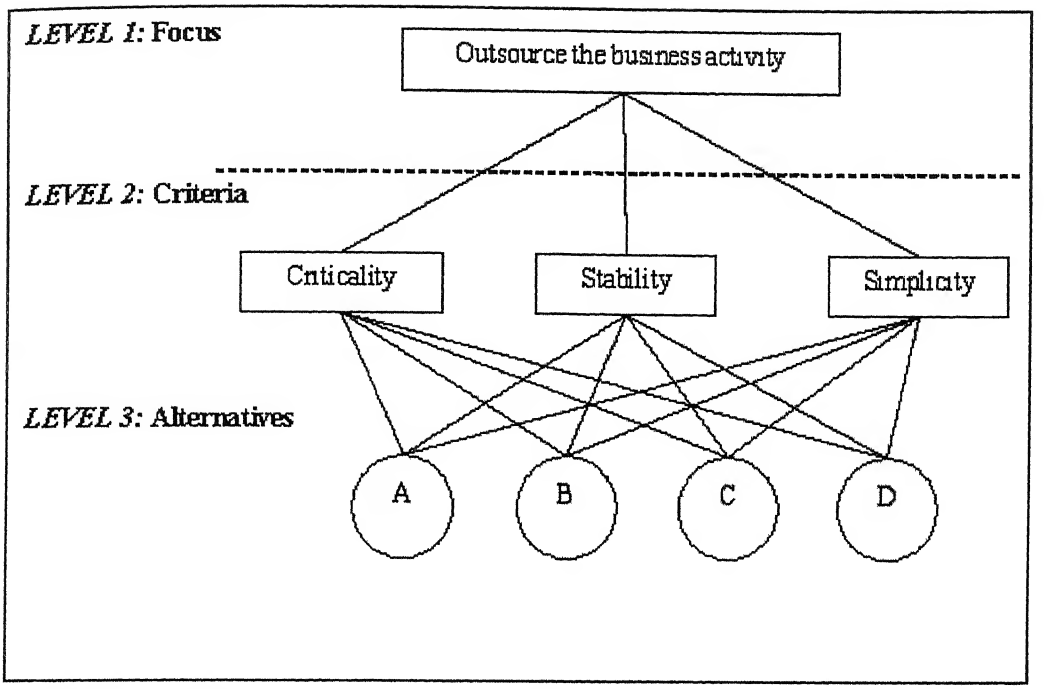

Figure 7: Decision-hierarchy 1 – "Which activity to outsource?"

In practice, a pairwise comparison matrix as shown in **Table 3** will have to be filled up by participants in the decision-making process. The three aspects of an activity are compared pairwise. In doing these comparison, decision makers will have to answer questions like "Given our present business position and the strength of our IT department, which attribute of an activity is more important for us in deciding whether we want to outsource it or not?" For example, a company with extremely weak IT department might rate Simplicity of an activity as a much more important criterion than its criticality or stability.

Table 3: Pairwise comparison for criteria in deciding which activity to outsource

	Criticality	Stability	Simplicity
Criticality			
Stability			
Simplicity			

Subsequently, the decision makers would be required to compare each of their IT activities among themselves, pairwise, on the criteria of criticality, stability and

simplicity. The questions that need to be asked are "Is activity A more critical to my business as compared with activity B?", "Is activity X more simple to undertake in-house than activity Y?" etc. This is done using a pairwise comparison matrix as shown in

Table 4: Pairwise comparison matrix for IT-activities based on one of the three criteria- criticality, stability and simplicity

	Activity 1	Acitivity 2	.....	Activity N
Activity 1				
Activity 2				
.....				
Activity N				

After obtaining data for these four matrices, the final priority vector is calculated as already described in Figure 6 (Chapter 1)The final priority vector reveals how suitable or how necessary it is to keep the activity *in*-house. Consequently, the activities with lower values of priority are more suitable for outsourcing.

2. Deciding the outsourcing methodology

The decision-making hierarchy for this decision is shown in Figure 8. At Level 1 is the goal, or focus, i.e. to "extract business-value from IT Outsourcing". At Level 2, are the criteria for achieving this goal – solving short-term business problems, improving the business and transforming the business. At Level 3 are the sub-criteria for the criteria at Level 2. Finally, at Level 4 are the alternatives i.e. the contracts.

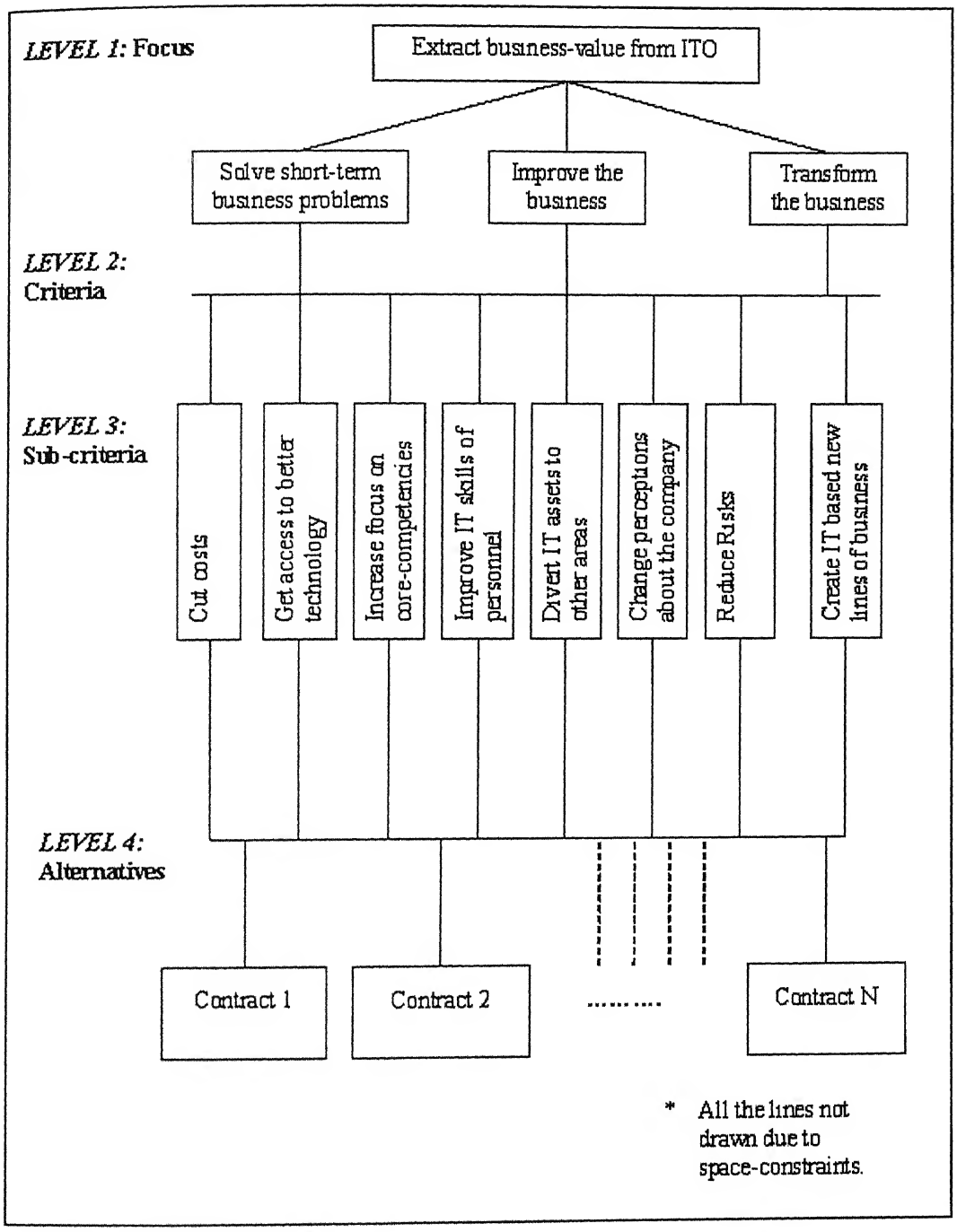

Figure 8 Decision-hierarchy 2 – "What outsourcing methodology to follow?"

The first step is to decide the priorities of the business. The overall focus, or goal, has already been decided – "extract business-value from ITO". However, the company has complete flexibility in the criteria for meeting this focus. Formulation of the criteria

may be adversely affected by paucity in the knowledge of the company regarding potential benefits of ITO. Hence, the various ways in which a company can extract business-value out of IT Outsourcing have been divided into the following three classes.

1. Use IT Outsourcing to help *solve the immediate business problems.*

The business may be going through several immediate problems due to which it may decide to outsource its IT capabilities. Failure to carry out the IT functions properly, higher levels of investment in IT (human and capital) than the business can afford and lack of focus on core competency areas of the business etc. resulting in falling profit margins, reduced investor confidence and adverse effects on market value are some of the short-term problem areas for most companies.

2. Use IT Outsourcing to *improve* the business.

ITO offers not only immediate short-term opportunities but also extends long-term advantages to the business, by allowing it to improve its processes re-think it business strategy and enhance its capabilities. This can be achieved by enhancing the IT skills of personnel, improving efficiency and effectiveness of business processes, and enhancing the company's image.

Most IT Outsourcing deals involve intense interaction between the IT staff of the customer and supplier. Moreover, in the process of providing its services, the supplier exposes a considerable portion of the skills of its personnel to the customer. In some cases, the contract may include a clause for training customer personnel as well. All this serves to improve the human resources and technical expertise of the company in terms of the IT potential.

Secondly, Outsourcing enables the company to enhance the efficiency of its business processes. By making the various business processes IT-enabled, the company can enhance their efficiency significantly and thus improve the business in the long term.

Finally, IT Outsourcing may enable the business to enhance its image. The company is able to focus on its core competencies and hence improve quality of

operations. This is different from the short-term objectives of restoring investor/market confidence in the face of negative trends in the stock markets.

3. Use IT Outsourcing to *transform* the business.

While planning for Outsourcing the business might go through the exercise of studying its business from a zero-based perspective, neatly laying out the various processes, system boundaries and process interactions. Thus ITO planning enables (requires) the company to take a fresh look at the way the business operates and transform the way it does business, if so required. The kind of opportunities open here are to open new lines of business based on IT, to transform the business gradually into a virtual corporation or to realign business in line with new trends such as web-services. A company making the IT outsourcing decision can use the opportunity to strengthen its IT department to a point from where it can spin it off into a separate unit of business or diversify into new areas. To do this, the company will have to enter into a value-added outsourcing deal with the supplier, whereby both the customer and the supplier combine strengths to market IT products and services. Once a certain level of specialization is reached in the particular product or service, the company may go for the spin-off, either on its own after termination of the contract, or along with the supplier as a joint venture. Thus, the company develops fresh competencies. ITO also offers the business the unique opportunity to redesign its business model as a virtual corporation by forging co-sourcing and value-added deals with various suppliers for the entire business processes, including IT. The web-services model is a new business paradigm in which various IT activities will be available online on a pay-for-use basis. Various functions are made available online by describing their interfaces through standards. These can then be plugged into existing business processes as desired.

The three objectives mentioned above will have varying levels of relevance to the overall goal of deriving business value from ITO. They have been compared through the pairwise comparison matrix shown in Table 5.

Table 5 Pairwise comparison at Level 2 for deciding which sub-objectives contribute more to the overall goal of extracting business value from ITO.

	Deriving short-term benefits from ITO	Using ITO to improve the business in the long-term	Transform the business.
Deriving short-term benefits from ITO			
Using ITO to improve the business in the long-term			
Transform the business			

The second step is to decide which courses of action are more relevant for a particular objective. That is, from among the various potential benefits of ITO, which ones does the company find more relevant for its objectives. The following are the courses of action that may potentially follow from ITO:

Table 6: Potential Benefits from ITO.

1	Reduction in costs
2	Access to better technology and better skills
3	Increased focus on core competencies
4	Improvement in IT skills of personnel
5	Liquefaction of IT Assets and improvement in cash flow
6	Enhancement in customer-relations through improved service delivery levels
7	Mitigation of risks involved in IT investment such as technical obsolescence
8	Spin-offs and diversifications

The choice of these potential benefits of IT is based upon the literature survey. The most common benefits that businesses expect to extract from ITO have been considered here. These sub-criteria will have varying levels of relevance to the business objectives at Level 2. They have been compared through the pairwise comparison matrix shown in Table 7.

Table 7: Pairwise comparison at Level 3 for deciding which courses of action are more aligned with the business sub-objectives of Level 2.

	Costs	Get access to better technology	Increase focus on core competencies	Improve IT skills of personnel	Liquefy IT Assets and improve cash flow.	Enhance customer-relations by improving	Mitigate risk involved in IT investment such as technical	Create new IT based lines of business
Costs								
Get access to better technology								
Increase focus on core competencies								
Improve IT skills of personnel								
Liquefy IT Assets and improve cash flow								
Enhance customer-relations by improving service delivery levels								
Mitigate risk involved in IT investment such as technical obsolescence								
Create new IT based lines of business								

At Level 4 are the several alternative contracts through which the activity (represented by the shaded circle) may be outsourced. These alternatives may vary across many dimensions. Essentially most contracts can be classified into the following general categories.

1. *Insourcing*: The Company should let the IT department take over the responsibility for the activity. This presumes a high level of agreement between

the maturity of the IT department and the complexity of the activity. It is also a preferred alternative if the activity is a critical differentiator.

2. *Value-added Outsourcing*: The Company should enter into a close and strategic alliance with the supplier. Technology sharing and transfer, personnel exchange and training are desirable characteristics. Here, there is considerable margin for the company to use innovative alliances.

3. *Short-tem Outsourcing*: The activity should be outsourced for a short period. This presumes a moderate operations' maturity of the IT department. The expectation is that the department will quickly learn from the supplier and become competent enough to provide the service itself in a short period. It also serves to mitigate risks like technical obsolescence and unsatisfactory vendor performance. Moreover, short-term outsourcing may be done if the company has adopted a wait-and-watch policy for outsourcing.

4. *Long-term Outsourcing* The activity should be outsourced to a vendor for a long period. This presumes a low operations' maturity of the IT department, a low interest of the company in diversifying to IT-related lines of business, a high level of trust in the vendor and ability to take risk.

Identifying a contract as belonging to one of the above categories allows the company to identify some advantages/disadvantages of the particular contract straightaway. These contracts are then compared against each other pairwise on each of the criteria listed in Table 6 Using the algorithm of Figure 6 (Chapter 1), the priority vector for the various outsourcing alternatives is obtained. *Expert Choice*, or any other AHP software, is then used for analyzing the responses. The alternative with the highest priority is selected as the course of outsourcing the activity. In the next chapter, this model is applied to the ITO decision at TELCO Lucknow.

CHAPTER 5 Survey Methodology

1. Overview

A model does not have much utility unless it is verified through application to real-life problems. Verification can be done either by trying to solve a new problem, or by applying the model to a problem that has already been solved and comparing the results obtained against the actual results. In the present work, the latter approach is chosen. Based on the decision hierarchies constructed, a survey was prepared to obtain data from organizations that have been involved in some form of outsourcing in the past. Several organizations were informed about the survey and requested to participate in it. The survey was made available on the internet by hosting it on the IIT Kanpur website. The survey was also prepared in MSWord format and sent through email to those organizations that felt more comfortable with such "offline" participation. Various organizations contributed to the survey, of which the responses from Tata Engineering and Locomotive Company (TELCO), Lucknow were found to be most appropriate on account of the hierarchical level of participants in their organization, consistency levels of the responses and size of the data-set (in decreasing order of importance).

2. Design of Survey

Due to the size of the survey, its internet-based implementation was split into two HTML pages. Each page consisted of pairwise comparison matrices for making comparisons between all pairs of nodes at a particular horizontal level, with respect to one of the nodes in the adjacent higher level. The arrangement was found to be complex from a nonprofessional's point of view; hence, an explanatory help-file was provided explaining the comparison process. For ready reference, the standard comparison chart proposed by Saaty [Saaty, 1980] was also kept at a distance of just one click throughout the survey. The data submitted by the user through the HTML forms was then collected through Java Servlets running on a Tomcat web-server. These Servlets put the data from each participant into a separate text file. The internet version of the survey was hosted on

a sub-domain within the IIT Kanpur website – http://www.mba.iitk.ac.in*. Preparation of the MSWord format of the survey was trivial once the internet format was ready.

After collection of the data, *Expert Choice*# was used to analyze the data. Due to the small size of the hierarchy and the data set, a trial version was found sufficient for the analysis.

3. Responses and Selected Case

The responses were initially lukewarm. Most organizations that had initially agreed to participate opted out. When inquired, several reasons were cited. Firstly, the survey-form took a lot of time to fill up. The total number of comparisons that were to be made in any particular instance of the survey amounted to $3(nC_2)+3C_2$ in case of the first decision hierarchy, and $8(mC_2)+3(8C_2)+3C_2$ in case of the second decision hierarchy; where n is the number of activities and m is the number of contract options. For a set of four activities and four contract options, this amounts to 156 comparisons! This was cumbersome and a major deterrent to participation in the survey. Secondly, the comparison methodology was difficult to understand without proper illustration and explanation. Finally, the requirement of consistency in comparisons within a matrix of dimensions up to $8 X 8$ (at Level 3 in Decision 2) required a lot of effort on the part of the respondent and considerably lowered his/her motivation. As a result, the number of respondents from many individual did not exceed five or six.

However, the response from TELCO Lucknow was earnest and unreserved. Twenty people from the middle and higher levels of management devoted their precious time to the survey. A brief case history of ITO in TELCO is as follows.

The internal IT department of TELCO had been efficiently performing all the IT activities related to TELCO Lucknow during the 1990s. In the late 90s, it was decided to

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* This sub-domain had earlier been used for hosting the online application form for admissions to the MBA batch of 2003.

Downloadable from http://www.expertchoice.com for a trial period of 15 days

spin-off the IT division of TELCO into a separate entity known as Tata Technologies Limited (TTL). The drivers behind this decision were:

1. Increase focus on the core competencies of TELCO.

2. Extract business advantage from in-house capabilities by supplying IT Services to third-party customers outside TELCO.

3. Ensure benchmark remunerations for personnel involved in the IT department and present them with career-growth opportunities. This would ensure retention of good quality personnel.

Since then, TTL has consistently been delivering high quality IT services to TELCO and has developed a large and diverse third-party clientele as well. In due course of time however, the need was felt for TELCO to have a website. Already the websites of major TATA group companies were being managed by Tata Consultancy Services (TCS) through its sub-contractors, mainly domain-b.com. However, TELCO chose to have its own, independent websites for various purposes. These websites were to serve various different purposes such as giving TELCO a "web-presence", enhancing its image as a more IT-savvy company, allowing vendors and suppliers to interact with the company etc. For this purpose, TTL was assigned the task of designing the new websites. A digital design company KPIL.NET was roped in as a sub-contractor. This company now designs and maintains TELCO's websites. The focal point of the survey was to analyze this decision of TELCO, from within the decision making model proposed in the present work. It is noteworthy that the decision had already been taken and the hence the analysis was *post-facto*.

4. Participants

Out of the twenty respondents from TELCO, two had to be rejected due to inconsistency levels of most of their responses being higher than the threshold value of 0.1. The hierarchical distribution of the remaining eighteen participants was as shown in Figure 9

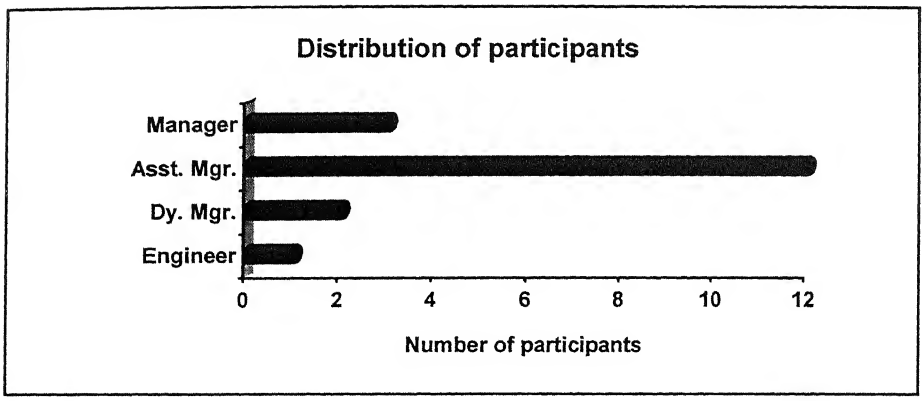

Figure 9: Distribution of participants in the survey conducted in TELCO, Lucknow.

This distribution was conducive to the nature of the survey as it mostly involves higher decision-making levels as well as people who have a pulse of the operational aspects of the company.

5. Results and Analysis

The first question asked of the respondents was with respect to level 1 of decision 1. The respondents were asked to compare the relative importance of criticality, stability and simplicity of an activity while making the decision to outsource it. The aggregated of the responses to this question is shown in Figure 10

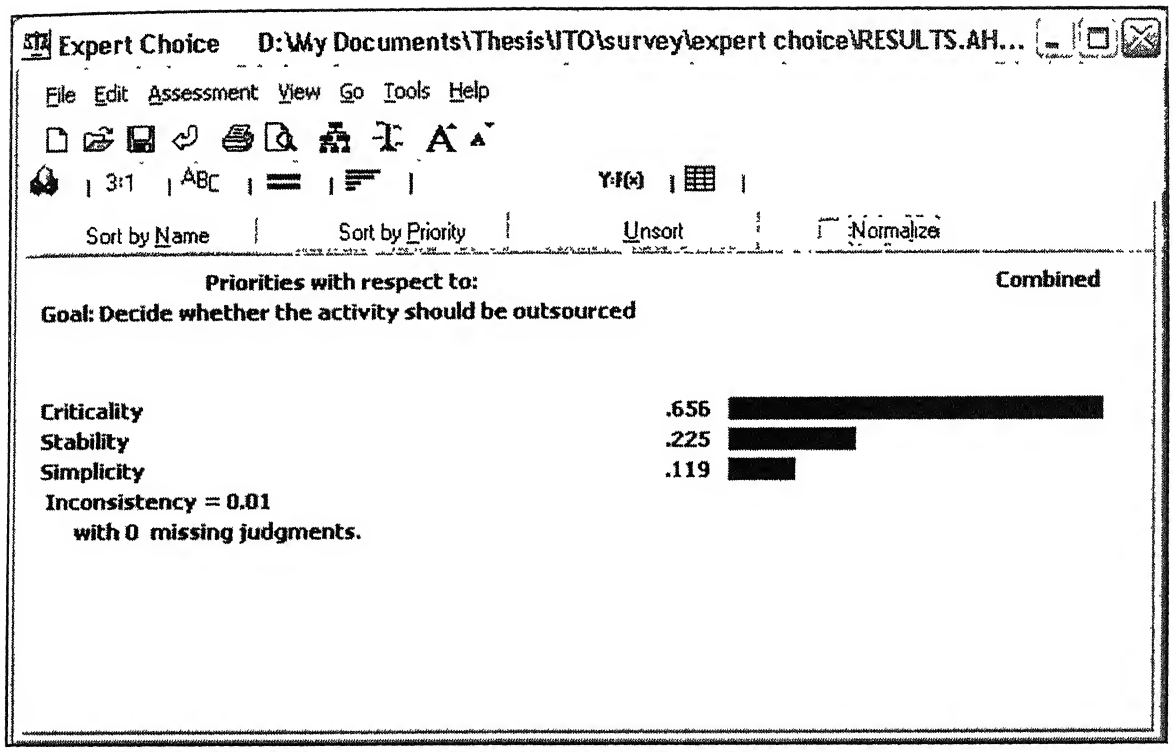

Figure 10: Priority Vector for the factors in choosing an activity to outsource.

Thus, the criticality of an activity was the most important criteria in deciding whether to outsource it or not. This was followed by stability and simplicity in that order. This suggests that TELCO Lucknow was very confident of its internal IT capabilities. Whether technology related to an activity is complex or subject to change is secondary, as compared to the nature of the activity itself.

After this, the respondents were asked to name any four IT-related activities of their organization. A collective response was taken, as this information had to be uniform across the data set. These four activities were

- Materials Requirement Planning (MRP)
- Finance
- Human Resource Management such as payroll, benefits etc.
- Website development and maintenance (WDM)

Having obtained these responses, the respondents were asked to make pairwise comparisons among the four activities on the criteria of criticality, stability and simplicity. The aggregated responses were as under:

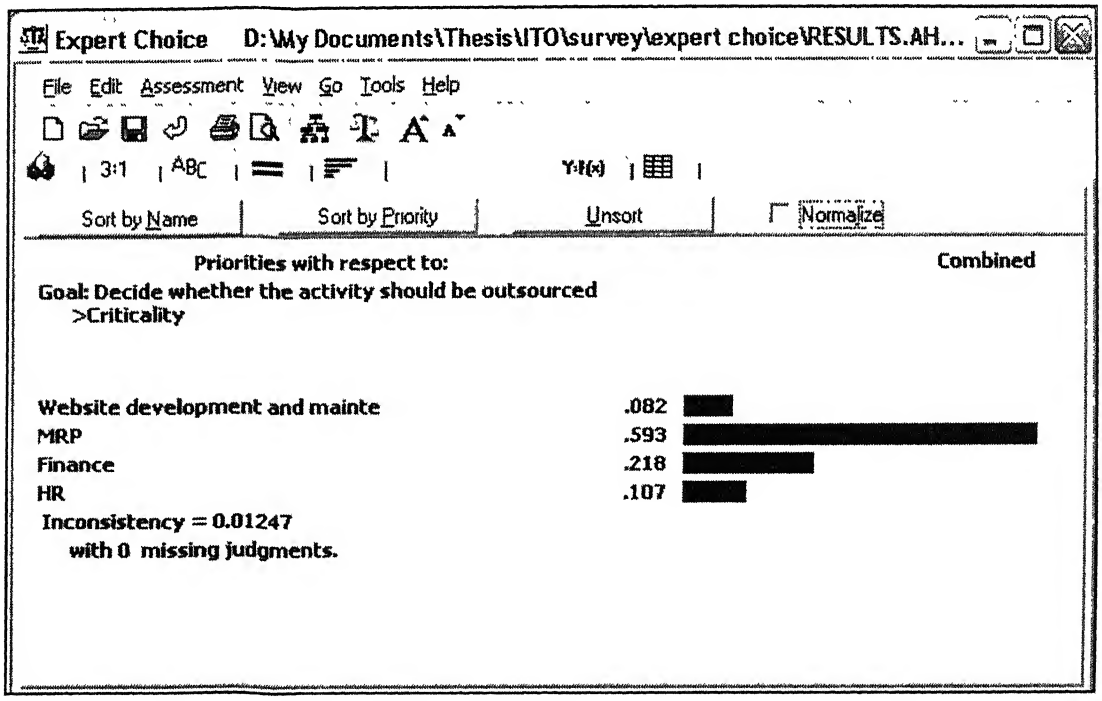

Figure 11: Priority Vector for the four activities with respect to Criticality.

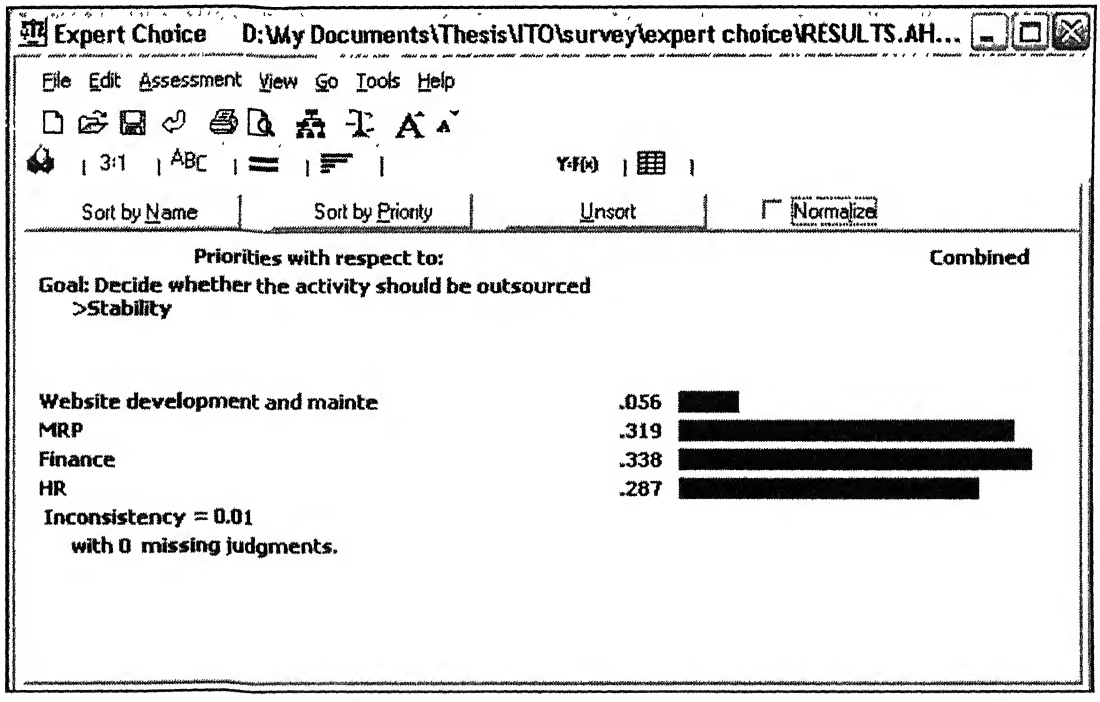

Figure 12: Priority Vector for the four activities with respect to Stability.

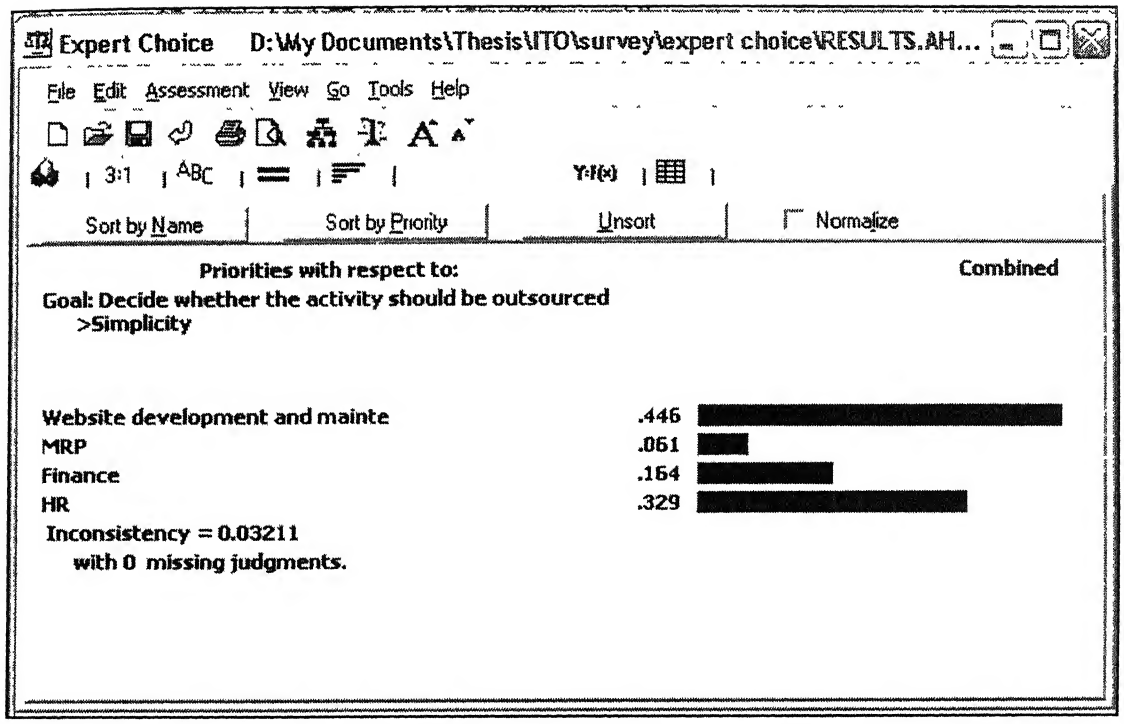

Figure 13: Priority Vector for the four activities with respect to Simplicity.

From the above results, it is clear that MRP is perceived to be the most critical and most complex activity among the four chosen. Improper or inefficient functioning of MRP systems may cause considerable problems for an automobile company due to increase in back-orders or inventory. As one respondent said, "MRP is the backbone of the whole organization. A company like TELCO would think 10 times before outsourcing it to some outside supplier". MRP is one activity of the company that is heavily interdependent with other activities and this, as already noted, makes it highly critical. However, MRP is regarded as a moderately stable activity i.e. software and technologies related to this activity do not become obsolete in the short-term. Most legacy MRP systems remained more or less unchanged for long periods prior to the emergence of ERP.

Finance is not as critical as MRP for TELCO's business in the aggregate judgment of the respondents. Finance functions are uniform across various organizations. While errors in performing this activity may prove to be very costly, the maturity levels of Finance-related applications and the lower cost of such errors when compared with errors in MRP have been cited as reasons in justification for this judgment. Finance is the

most stable function of the organization due to the routine nature of the issues involved and high maturity in technologies. Its complexity, however, is next only to MRP in TELCO, according to the respondents.

WDM is the least critical, and rightly so for an automobile firm operating in a traditional market. In contrast to automobile firms in the developed nations, where the websites are used for important functions such as 3-D modeling, sales and complaint management, TELCO views its website as a less important business tool. Moreover, WDM is seen to be the least stable activity as well. This choice emerges from low-levels of maturity of the website industry with new tools, methods and designs of websites emerging on a regular basis. Due to this there will always be a considerable amount of risk involved in keeping the website function in-house (due to technological obsolescence). This function, however, is not considered very complex. On the criteria of simplicity it gets the highest score i.e. 0.446. Thus, WDM is perceived as the most simple, but highly unstable and non-critical activity.

In the final analysis, WDM emerges as the most suitable activity for outsourcing due the lowest priority of 0.121 in the final priority vector, as shown in Figure 14.

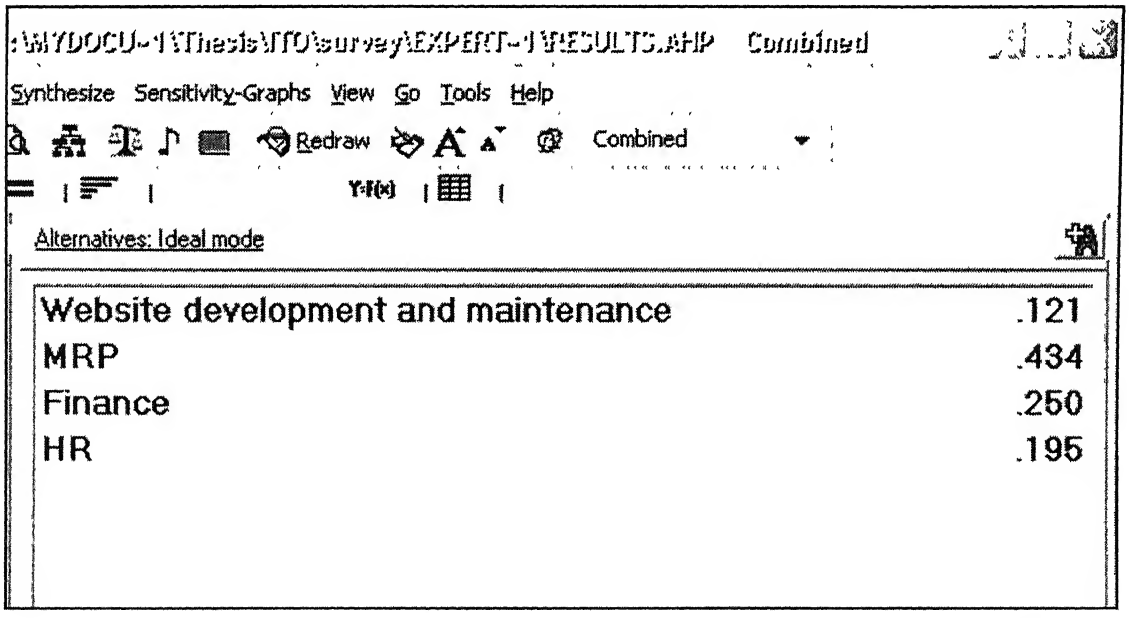

Figure 14: Final priority vector for the activity-choice decision for TELCO.

For the second part of the decision i.e. choosing the right methodology for outsourcing, WDM is chosen as the base-activity for making all the comparisons. The respondents were asked to list the options that were available to them at the time of making the outsourcing decision. Four of the main options were as follows:

- The internal IT department (now TTL) could do the job.
- A value-added contract with a specialist company (for e.g. domain-b.com the company that was managing and maintaining websites of many TATA companies at that time) could be forged. Technology and skill-transfer could be availed of over the period of the contract and gradually the activity could be brought back in-house.
- A short-term contract with any local provider in the region would also have worked because of the low-criticality of the work and low costs of such a deal.
- A long-term contract with KPIL.NET, a fast emerging digital design company that was known for its aesthetic design, could also be affected.

As already noted, KPIL.NET was given the contract. We analysed this decision from within the framework of the model suggested in the present work. The respondents were first asked to pairwise-compare the business objectives behind ITO i.e. what benefits the company expected to draw from outsourcing its IT functions. The aggregate response is shown in Figure 15

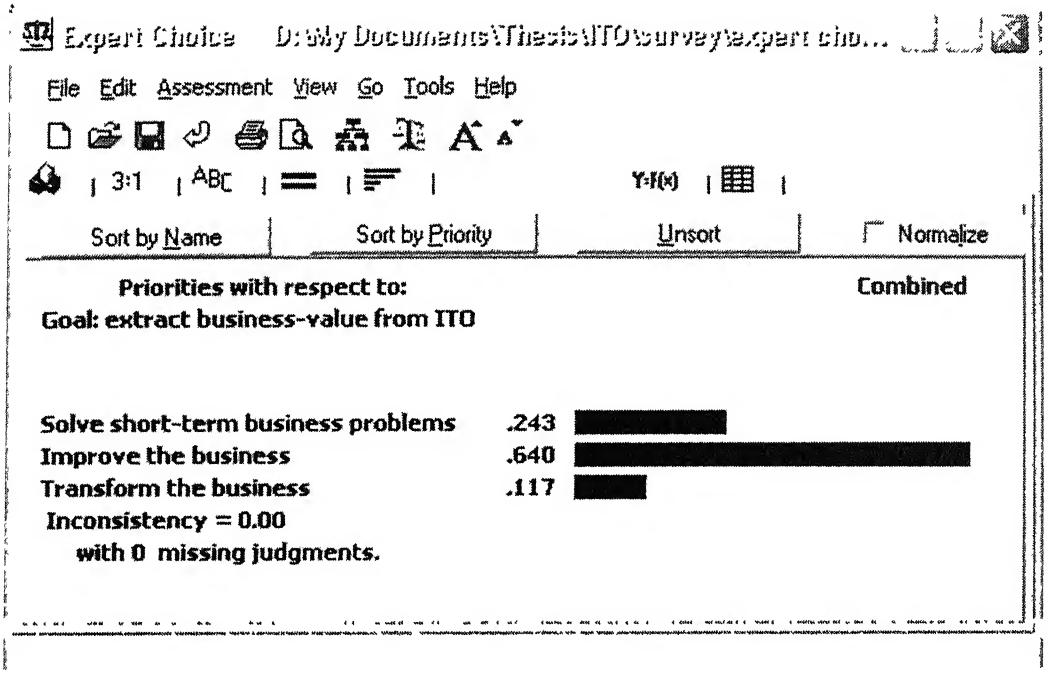

Figure 15: Priority vector for business objectives in pursuing ITO.

It is clear from the figure that TELCO was interested in improving the business while outsourcing its IT activities. The second priority was solving its short-term business problems and transforming the business was lowest in priority. As a part of one of the largest business conglomerates of India, TELCO is relatively better cushioned against short-term problems. On the other hand, increasing competition from various quarters had raised the concern for an improvement in the business.

After this, the respondents were asked to pairwise-compare the various courses of action open to them with respect to short-term problems, long-term improvement and complete transformation in the business. The results obtained are shown in Figure 16, Figure 17 and Figure 18.

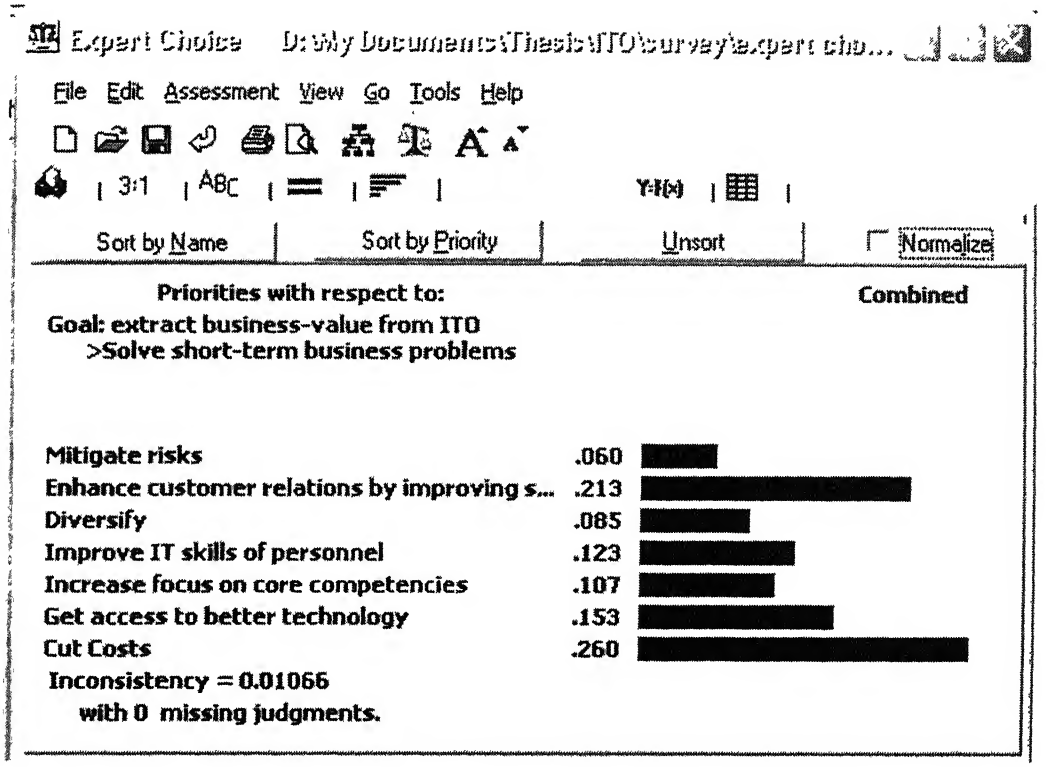

Figure 16: Priority Vector for various courses of action for solving short-term business problems.

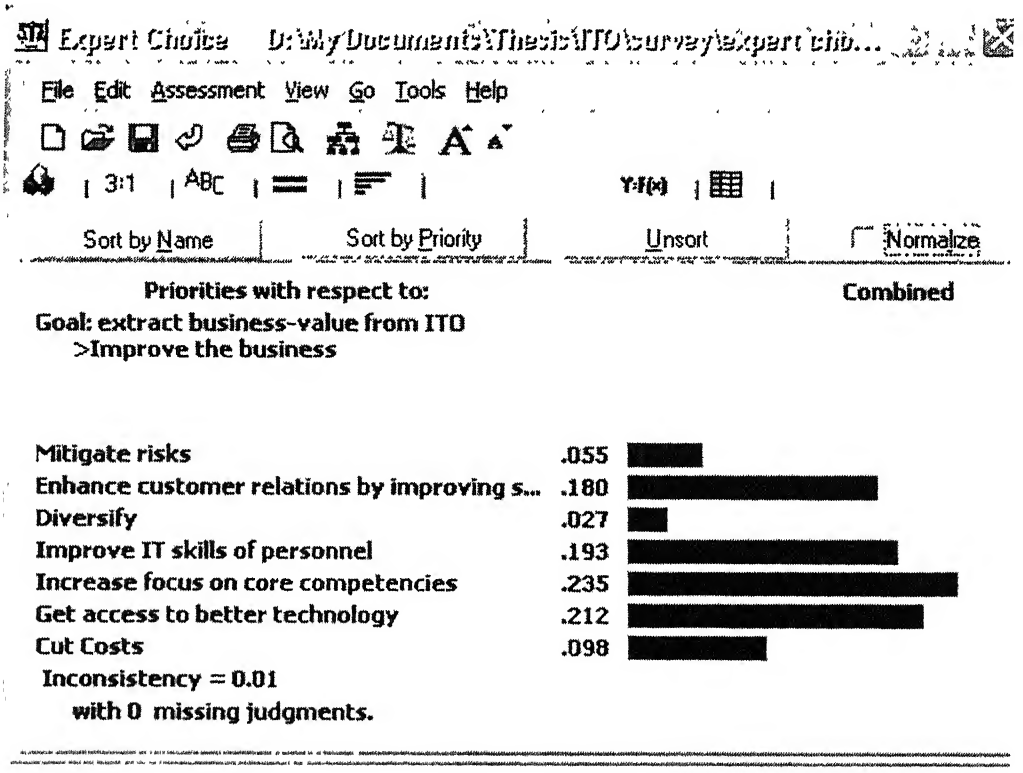

Figure 17: Priority Vector for various courses of action for improvement in the business in the long-term.

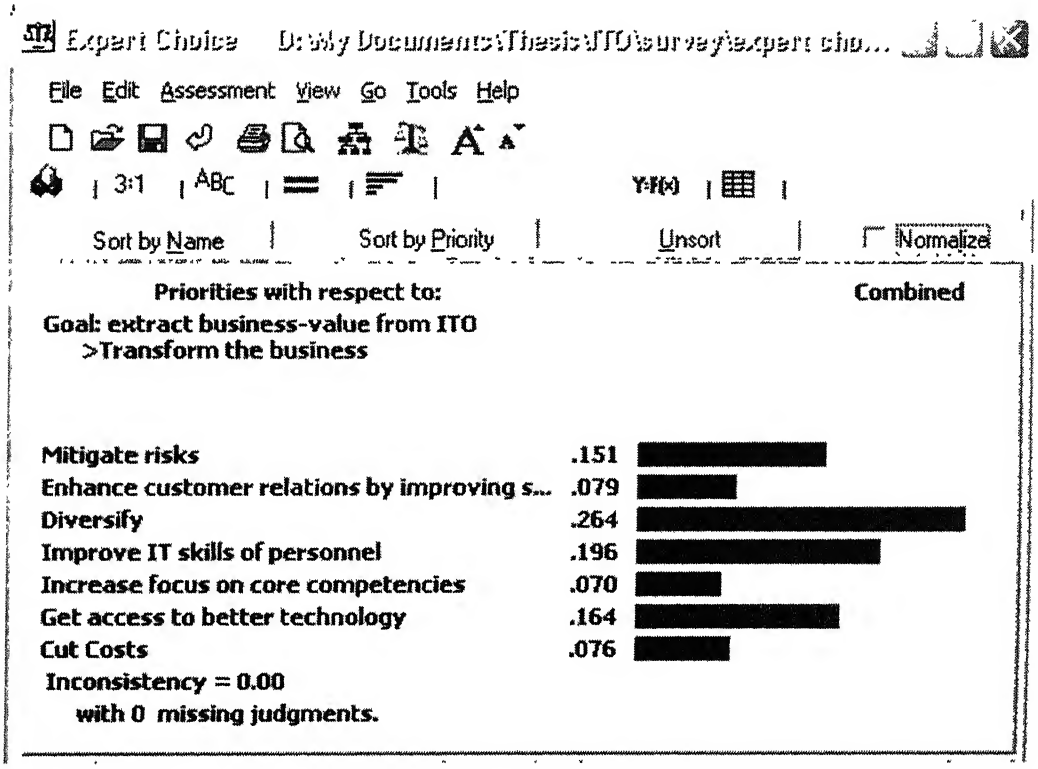

Figure 18: Priority Vector for various courses of action for transforming the business.

From the above figures, it is clear that for improving its business, which is TELCO's top objective in ITO, the respondents feel that the emphasis is on enhancing customer satisfaction by improving service-delivery levels, getting access to better technology, increasing focus on core competencies and improving skills of IT personnel. Of these, the most important objective in their opinion is to increase focus on core-competencies. The short-term advantages it would like to draw are a reduction in costs and increased customer satisfaction levels. For transforming the business, the main thrust is on diversification. However, this response betrays a superficial interpretation of transformation. The real implications of business transformation are to radically alter the basic paradigms of the business i.e. switch over to an entirely new business model such as a virtual corporation or the web-services model. However, the responses show that an established and traditional firm like TELCO cannot be expected to think along such lines.

The last decision level was of comparing the various outsourcing options against the amount of contribution each can make towards a particular benefit such as cost-reduction etc. The responses are summarized in Figure 19

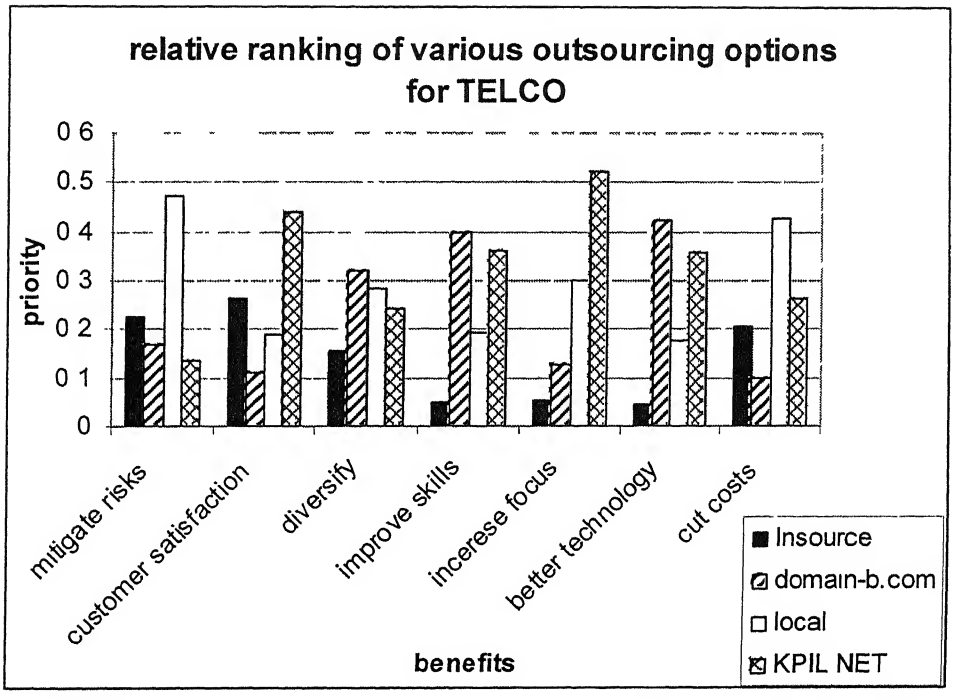

Figure 19: Relative priority of various outsourcing options with respect to the potential benefits of ITO.

The following observations are made from a close look at Figure 19.

- Outsourcing WDM to KPIL.NET will give TELCO maximum advantage in terms of focusing on its core-competencies. When asked, the respondents said that KPIL.NET was offering to take over not just the development, but the infrastructure part of the website as well. Hence, TELCO would be relieved of all hassles related to the activity such as network, servers, bandwidth etc. allowing it to focus the most.

- In terms of cutting costs, outsourcing to the local provider was the clear choice. Domain-b.com was perceived as the least beneficial in this case. This might sound contrary to common sense where a larger provider is able to provide a service at lower cost due to economies of scale. However, in case of IT related functions, especially volatile activities such as website development, the same may not hold true. This is verified through practical studies as well, where more and more companies are now doing atomic outsourcing to small and medium-sized service providers.

- The local provider was also perceived as the most risk-free option, while KPIL.NET was seen as the most risky option. The reasons respondents gave for these was that TELCO could exit from the former very easily as compared to the other options. KPIL.NET was a relatively new company at the time and the contract entailed transfer of the website function in its entirety. This was interpreted as putting too much in the hands of a company that has too little credentials.

- For improving the skills of its IT personnel, outsourcing to KPIL.NET lagged behind domain-b.com. As already mentioned, the contract with domain-b.com was of a value-added nature whereby a lot of sharing of technology and skills was implied. Similarly, for getting access to better technology domain-b.com was perceived as a better option.

After processing the data obtained by the respondents above, the priority vector obtained for the four outsourcing options is shown in Figure 20. This vector clearly shows that KPIL.NET is the most suitable option for outsourcing the website function of TELCO. It should be noted that the choice of KPIL.NET was the result of high priority of the company in improving its business rather than solving its short-term business problems. Improvement in business was perceived as a function of enhancing customer-relations, improving IT skills of personnel, increasing focus on core-competencies and getting access to better technology. On the latter two accounts, the performance of KPIL.NET was much better than the other options and hence the choice.

Alternatives Distributive mode	
insourcing	.124
domain-b.com	.242
local service provider	.264
KPIL.NET	.370

Figure 20: Final priority vector for the four outsourcing options for TELCO.

CHAPTER 6 Conclusions and directions for Future Work

In this work, a decision making model for Information Technology Outsourcing (ITO) was developed using the Analytic Hierarchy Process (AHP). Although AHP is a widely used method, its application in the field of ITO is rarely found in literature. The model developed was verified against an actual outsourcing decision made at TELCO, Lucknow. Although the model was not adjusted for the specific case in question, the results are in congruence with the actual decisions made. This suggests that the drivers, issues and problems in IT strategies, including that of IT Outsourcing, transcend the boundaries of industrial segments. Hence, the proposed model, which is based on these common issues, is generic enough to incorporate different industry segments and business situations.

In this work, only one case could be taken up for verifying the proposed model because of time and resource constraints. Many more cases can be taken up and used to validate the model further.

The formulation of the decision hierarchy proposed in this work was based upon the literature survey done by the author. However, modifications in the hierarchy are possible. For instance, the set of criteria at the third level in the outsourcing methodology decision could be modified by adding more criteria. Similarly, another level can be added in the activity choice decision to break up the criteria of criticality, stability and simplicity into more objective sub-criteria.

The present work concentrates on only a part of the entire ITO process (See Figure 21). Issues such as vendor selection, ascertaining internal IT capabilities, and ascertaining market situation of ITO have been omitted. These are all highly subjective issues and hence models based on AHP, similar to the ones proposed here, can be developed for them.

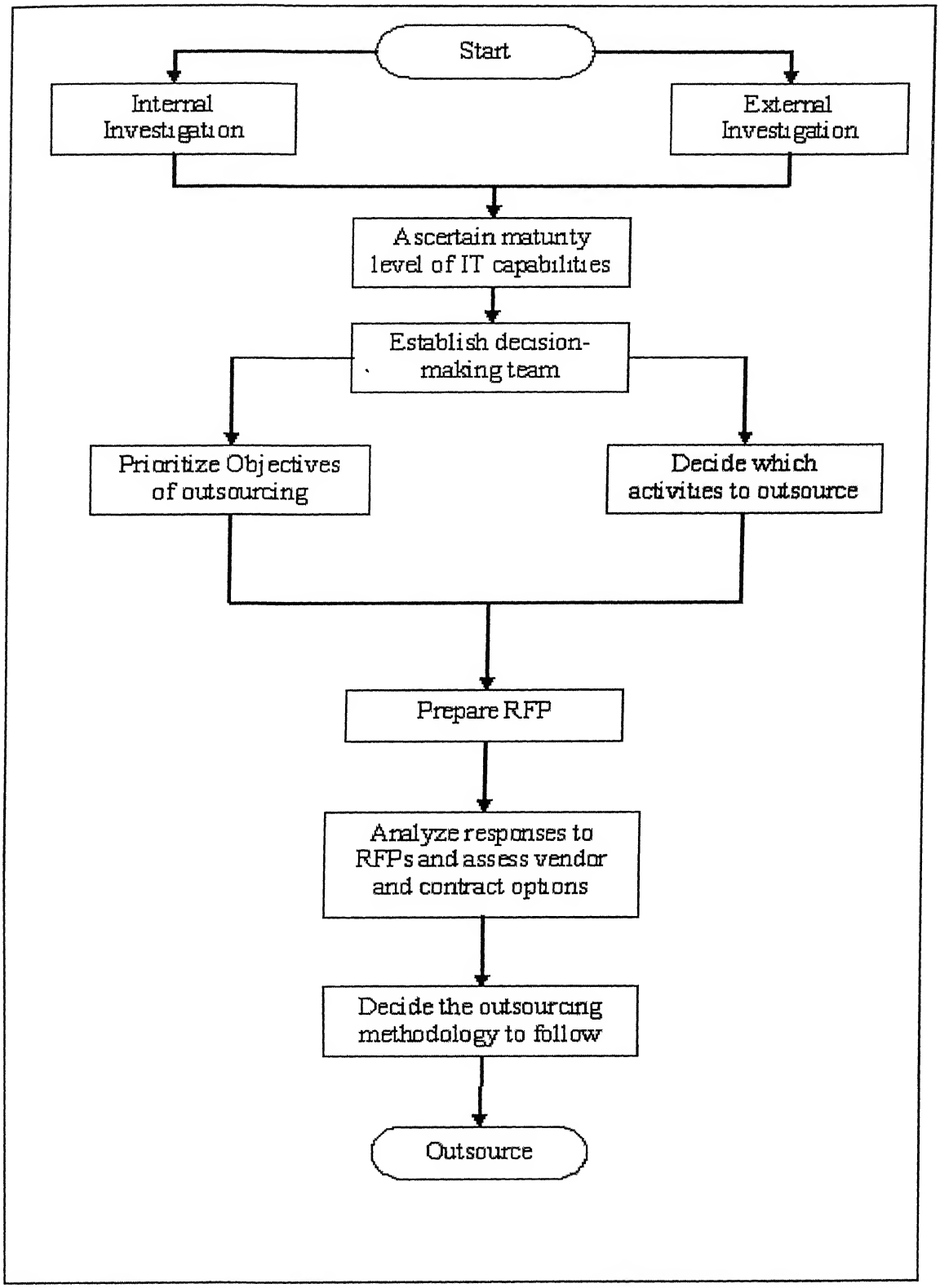

Figure 21: The ITO decision framework: The shaded boxes represent the areas of focus of the present work

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